may be able to reduce it to an acceptable level. In such cases, use solution analysis to monitor and verify progress. However, adding acid to the water may be necessary. See the cover sheet *Understanding the Solution Report* for an explanation of the **acid requirement (AR)**.

> **CAUTION:** *Use extreme care when mixing acid and water. The chemical reaction can cause acid to splash into eyes or onto skin and clothing. Always add acid to water, not the reverse. Add it slowly in very small portions and mix thoroughly before adding more. Wear safety goggles and protective clothing; have a large supply of clean water readily available to flush any area of the body contacted by the acid. Do not work alone; have an assistant nearby who can summon medical assistance, if necessary.*

Additional resources

Producing tobacco transplants in greenhouses: Water quality, NC Coop Ext Publ AG-488-3

Burley tobacco information, NC Coop Ext Publ AG-376

Flue-cured tobacco information, NC Coop Ext Publ AG-187

Water quality guidelines for tobacco float systems, Kentucky Coop Ext Publ AGR-164

Float greenhouse tobacco: transplant production guide, Virginia Coop Ext Publ 436-051

Tobacco seedling nutrition in the greenhouse float system, NC Coop Ext Publ AGW-439-48

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Solution Analyis for Tobacco Transplant Floatbeds

Best management practices

- Submit samples of source water for solution analysis annually, well before beds are filled.
- Take necessary corrective action before adding fertilizer and placing trays in beds.
- Submit samples of nutrient solutions for analysis every time fertilizer is added to beds.
- If you notice a nutrient problem, do not add fertilizer. Overfertilization tends to foster disease problems and increase salt content to harmful levels. Before you do anything, contact the NCDA&CS regional agronomist for your area (see www.ncagr.com/agronomi/rahome.htm). He/she can help you use solution analysis and/or plant tissue analysis to identify and correct the problem.

Planting

Sow seeds 50–55 days before the intended field planting date. Earlier sowing means seedlings stay in the greenhouse longer, *increasing energy costs and the potential for disease*.

Timing of fertilization

Do not mix fertilizer into floatbed water until after seedlings emerge. There is already enough fertilizer in transplant media to get seedlings through the first week or so of growth. Choose a fertilizer formulated for greenhouse production of tobacco seedlings. Rate of application

depends on floatbed volume, calculated as follows:

Volume in gallons = 7.48 × length × width × depth of floatbed measured in feet

Nitrogen (N)

Choose fertilizer based on pH of source water. Keep in mind that ammonium (NH_4) fertilizers tend to acidify the water and media, and nitrate (NO_3) fertilizers tend to have the opposite effect. Do not use urea.

Flue-cured tobacco seedling production requires a total of 250 ppm N. Apply 100 ppm 7–14 days after seeding (when plants have emerged, roots are in water and foliage is about the size of a dime). The remaining 150 ppm should be added about 4 weeks after seeding. The target N concentration in the floatbed nutrient solution should be 100–150 ppm at any given time.

Burley seedlings do fine with two equal doses of 100 ppm N. Apply the first at 7–14 days after seeding and the next at 4 weeks after seeding. Floatbed N concentrations should stay around 100 ppm.

Calcium (Ca) & Magnesium (Mg)

The best way to increase Ca is to add gypsum or a fertilizer containing Ca to floatbed water. Most tobacco fertilizers already contain Mg. If more is needed, apply Epsom salts based on solution report recommendations. Two ounces of Epsom salts per 100 gallons water provides 15 ppm Mg.

Note: Be aware that cold injury can look like calcium or sulfur deficiency. Cold injury can occur when a bright, sunny day is followed by a rapid and precipitous temperature drop at night.

Boron (B)

If your fertilizer does not contain B and the source water concentration is low (<0.5 ppm), add 1–2 ppm B to the floatbed. For example, 0.2 ounce of Borax (11% B) per 100 gallons water will supply 1.5 ppm B.

CAUTION: *Even low concentrations of boron can be toxic. Do not add B if the source water contains 0.5 ppm or more. If the concentration is high (>2 ppm), make sure that the fertilizer does NOT contain B, and look for signs of B toxicity. In this case, the high-B water may need to be diluted with water from another source that does not contain B.*

Table 1. Acceptable ranges for solution analysis parameters inproduction of flue-cured tobacco transplants (NCSU Crop Science Department)

Parameter	Source Water	Floatbed Nutrient Solution
N*	0–3	100–150
P*	0–5	35–50
K*	0–10	100–150
Ca*	20–100	40–100
Mg*	6–25	15–35
S*	0–25	15–35
B*	0–2	1–2
Cl*	0–70	< 70
Na*	0–70	< 70
SAR	0–4	≤ 4
EC**	0–75	50–100
Alkalinity*	0–100	0–100
pH	6.0–6.5	6.0–6.5
Hardness: no established range; little relevance		

* Units are parts per million (ppm)

** 10^{-5} Siemens/centimeter = 10^{-5} mho/cm

Electrical Conductivity (EC)

Once a fertilizer solution is well mixed (sump pumps can help), take EC readings every 24 to 48 hours, using a calibrated meter. Average readings taken from several places throughout the bed. To convert units of measurement, refer to your meter's manual or visit www.ces.ncsu.edu/depts/hort/floriculture/Florex/EC%20Conversion.pdf.

Solution report EC values greater than 150 indicate high salt content (perhaps too much fertilizer) and potential for root burn. Correct by dilution with good quality water. Low EC values (<50) may indicate low nutrient levels and the need for additional fertilizer.

pH

To raise the pH, choose a fertilizer with NO_3-N and/or Ca. Be aware that lime in the potting media can leach into the water and increase pH. Fertilizers with NH_4-N and/or analyses such as 15-5-15 or 21-5-20 tend to lower pH.

Sodium Adsorption Ratio (SAR)

High SAR values (>4) can signal potential for foliar uptake of sodium (Na) and leaf burn. To reduce SAR, add Ca using a source such as gypsum.

Alkalinity

Alkalinity measures total carbonates and is an indicator of buffering capacity. Because seedlings are grown in very small cells, high alkalinity can easily increase media pH. When alkalinity >100 ppm, corrective action is suggested.

If alkalinity is 100–150 ppm, use of acidifying fertilizers (e.g., 15-5-15 or 21-5-20)